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CLAYS AND CLAY INDUSTRIES OF CANADA*

By J. Keele, '93

The demand for structural materials in all parts of Canada which are already developed, or in process of development, exceeds very largely the home production. Clay products, as a matter of course, have been the materials most urgently required, and large quantities are imported yearly from the United States and Great Britain.

The need for building material is greatest in the prairie provinces, where wood and stone suitable for this purpose are of rare occurrence. These provinces are now looking to the possibility of utilizing their clay and shale resources. Several manufacturers from Eastern Canada and the United States are either erecting clay working plants or prospecting for suitable deposits in those regions.

The clay manufacturers in many parts of the Eastern Provinces are branching into new and better methods of production, and making a greater range and higher class of wares than formerly. At this stage of the development of the country the raw materials most sought for by the clay worker are those which make up into structural wares, such as building, paving and fire bricks, sewer pipe, electrical conduits, fireproofing, and field drain tile.

During the last four years the Geological Survey branch of the Department of Mines have carried on special investigations on the clay and shale resources of Canada. As it was important to get this information before the public as quickly as possible, the examinations were confined principally to deposits, situated on or near existing lines of transportation. Later on it was proposed to extend the investigations to those outlying districts which are reasonably sure to be provided with transportation in the future, which will bring any deposits found there into economic importance. A very brief review of our knowledge to date will be given here, and only with reference to the manufacture of the materials above mentioned.

Building Bricks

Surface clays suitable for the manufacture of common brick occur in all the provinces. Many of the larger valleys in Eastern

* Read before the Engineering Society, Dec. 11, 1912.

Canada are floored with extensive sheets of clay, the most notable being the great plain of the St. Lawrence in the province of Quebec, where clay is found up to 100 feet in thickness. Clay beds of smaller extent are also found at the higher levels up to 700 feet above the sea, where they occur chiefly as terraces, bordering streams. A very extensive sheet of clay, altogether detached from the southerly areas, is found along the line of the National Transcontinental Railway in Northern Ontario and Quebec.

Surface clays occur rather widespread in the provinces of Manitoba, Saskatchewan, and Alberta, especially in the Red River and Saskatchewan valleys.

There are large deposits of surface clays suitable for brick making

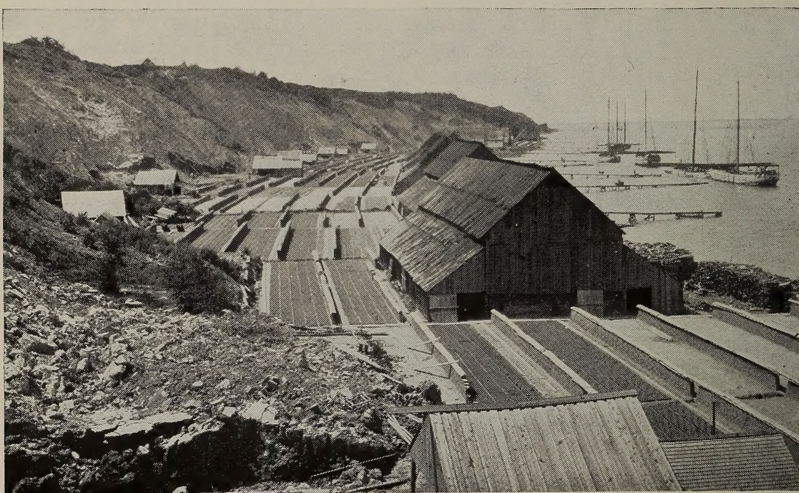

Fig. 1.—Chief Centre of the Common Brick Industry in the Province of Quebec, St. Jean Deschaillons, on St. Lawrence River

in British Columbia, particularly those of the Thompson River and Okanagan valleys in the interior, and of the Fraser River valley and the vicinity of Victoria on the Pacific coast. The surface clays are of recent origin, geologically. They are not consolidated and may be used directly as they are dug from the bank for brickmaking. They may come so close to the surface as to form the soil where crops are grown, or they may be covered with so much gravel or sand or swamps as to be inaccessible to the clay worker.

They have been laid down either in estuaries, like the marine clays of the St. Lawrence or Fraser River valleys, or in large bodies of water ponded between ice fronts and land margins, like those of the clay belt in Northern Ontario and Quebec and the Manitoba clays, or in lakes entirely surrounded by land, or along the margins of rivers. They vary in structure from stratified thinly bedded

clays, showing definite seasonal accretions, to massive or vertically jointed clays without any horizontal structure, seeming as if sedimentation were unceasing while the deposit was being laid down. The color of the raw clay is most generally bluish grey, but larger areas are of a red brown or dirty yellow. Their plasticity is usually good. With the exception of a portion of the Ontario clays which are buff burning, the eastern clays burn to a red color. The Manitoba clays are mostly buff burning, while the majority of the clays further west are red burning. The clays that burn buff contain a high percentage of lime. The surface clays in general have low fusing points. They will not stand overfiring, so that they are not adapted to the manufacture of vitrified wares.

Their principal use is for common brick made by the soft mud process. Some of these clays, however, can be made into bricks

Fig. 2.—A portion of the plant of the National Brick Company at Laprairie, Quebec

by the stiff mud or wire cut process, and into field drain tile. They are also used occasionally for making terra cotta lumber, or porous hollow blocks, by the addition of sawdust to the raw clay.

The surface clays are mostly unsuited to the manufacture of facing brick made by the dry pressed process, as they either give a brick with a soft porous body, or the shrinkage is so uneven after firing, that the bricks are too variable in size in the kiln.

Shales are clay sediments, deposited in still water bodies, frequently forming beds of great extent and thickness which have become hardened by heat and pressure. Most shales when finely ground and mixed with water have good plasticity, so that they can be moulded into any desired shape. Shales of value for making clay

products are found in all the older geological systems, even as low down in the scale as the Ordovician.

Slates are clay sediments in which the hardening processes have proceeded to such a degree as to destroy all plasticity. Such material is usually of little value to the clay industry.

Shales vitrify at low temperatures to dense bodies and usually make an exceedingly tough, strong product. They are of the greatest importance to the clayworker, and materially assist in the industrial development and wealth of the regions in which they occur.

Most of the numerous beds of shale in the Carboniferous system of Nova Scotia and New Brunswick are admirably adapted for the manufacture of a large range of clay products. In Quebec and Ontario the Medina shale of Silurian age and the Utica-Lorraine and Medina shales of Ordovician age are employed for brickmaking both by the dry pressed and wet moulded processes.

The Cretaceous and Tertiary shales and clays of the prairie provinces are worked to a limited extent already, with prospects of their being much more widely utilized. Many of these shales, however, which underly the western provinces, cannot be worked by wet moulded processes as they crack badly while air drying.

Beds of shale which may be utilized for brickmaking occur scattered through the mountain regions in British Columbia, these being generally of Cretaceous age. A thick series of shales of Tertiary age occurs at Sumas mountain, south of Mission Junction in the Pacific coast region. The latter excel all other shales so far found in Canada in their usefulness to the clay worker.

Paving Blocks

The paving brick shales are much more restricted in their distribution than the common and dry pressed brick shales. A shale suitable for this purpose must have slow vitrifying properties, and be able to withstand a fairly high fire without softening. The finished product must be tough, so as to resist impact without breakage, and have a low absorption in order to withstand the disintegrating effects of freezing and thawing. The coal measures in Nova Scotia and New Brunswick contain certain beds which are suitable for this purpose. The red Medina shales in Quebec and Ontario may by cautious burning be made into pavers, but the range between their vitrification point and softening temperature is too small to give the best results. In the province of Alberta, some of the Cretaceous shales have been found near Calgary, Lundbreck and at Entwistle, west of Edmonton, which are suitable for pavers. The best slow vitrifying shales which will make tough paving blocks, so far found, are those of Sumas mountain.

Fire Bricks

Those clays which will stand in firing to the softening point of cone 27 (1670°C) are classed as fire clays, and bricks made from them are used in various industries where a high degree of refrac-

toriness is called for. Fire clays occur in the Musquodoboit valley and at Shubenacadie on the Intercolonial railway line in Nova Scotia. A shale bed over a coal seam at Inverness in Nova Scotia and another under the coal at Flower cove, New Brunswick, so nearly fulfil the requirements that they may be provisionally classed as fire clays. Between the New Brunswick locality and the Dirt Hills region south of Moosejaw in Saskatchewan, we have not found anything approaching a fire clay, except in one instance where Kaolin or China clay occurs in Archaen rocks at St. Remi, about forty miles north of Montreal.

The fireclay beds in the Dirt Hills in southern Saskatchewan are of good workable thickness and fairly widespread. They are light grey, to white, highly plastic, and the most refractory clays at

Fig. 3.—Beds of white fireclay in the Dirt Hills, south of Moosejaw, Sask.

present known in Canada. They occur interbedded with impure shales, soft sandstones and lignites of Tertiary age.

The remarkable series of Tertiary shales at Sumas mountain contains one bed of fire clay, and another that approaches it very closely in refractoriness.

A residual clay from schistose rocks, which is a fire clay, is obtained at Kuyoguot, on the west shore of Vancouver Island.

With the exception of some beds of Kaolin on the Missinabi River in Northern Ontario, which are probably refractory, these are all the fire clay localities at present known in Canada.

Sewer Pipe

Clays or shales suitable for the manufacture of sewer pipe should be able to stand a fairly high temperature, at least cone 5 1230°C.)

without softening. They should burn to a hard impervious body, and take a good salt glaze. The localities already given for paving blocks apply also to sewer pipe as the requirements for both these wares are somewhat similar. A sewer pipe body may also be made up by using a smaller proportion of refractory shale or clay mixed with a more fusible one. The refractory clay acting as a skeleton, or support to the fusible part, the latter serving to give denseness to the body.

Electrical Conduits

These are hollow wares burned to a hard body, with smooth exterior surfaces to which a salt glaze is applied. They must be absolutely impermeable to water, and structurally sound, so as to withstand pressure when buried underground. They are generally

Fig. 4.—Pressed brick plant of Calgary Brick Co., Brickburn, Alta.

made from a dense burning clay or shale or from stoneware and shale mixed, or a mixture of fire clay and impure clays.

The Carboniferous shales of Nova Scotia and New Brunswick will supply the raw materials for these wares for the eastern market. The Cretaceous shales in Manitoba, the Dirt Hills clays in Saskatchewan certain shales in Alberta, and the Sumas mountain shales in British Columbia will furnish the Western raw materials.

Fireproofing

This class of hollow clay ware is coming into wide use, not only for casing in steel structures, and for floors and partitions, but also for walls of buildings, where the blocks alone are used.

Hollow blocks would seem to be the ideal building material for those provinces where wood and stone are so scarce. Buildings made of them, by reason of the air spaces in the walls, are warm in winter and cool in summer.

Fireproofing should be made from shale which has good plasticity, and capable of standing more fire than ordinary surface clay, as they must be burned hard without deforming, and have a fairly high compressive strength. Most of the Carboniferous shales of Nova Scotia and New Brunswick, the Medina shales of Quebec and Ontario, many of the Tertiary and Cretaceous shales and clays of the Western provinces are suitable for this purpose.

Clay-working Industry

The surface clays are worked in all the provinces to supply local demands for common bricks. So widespread are these clays, that bricks made from them are only rarely transported for long distances from the place of manufacture. The smaller plants are simple in operation, there being only one brick machine, and the green bricks are dried on the ground, or in open racks. There are

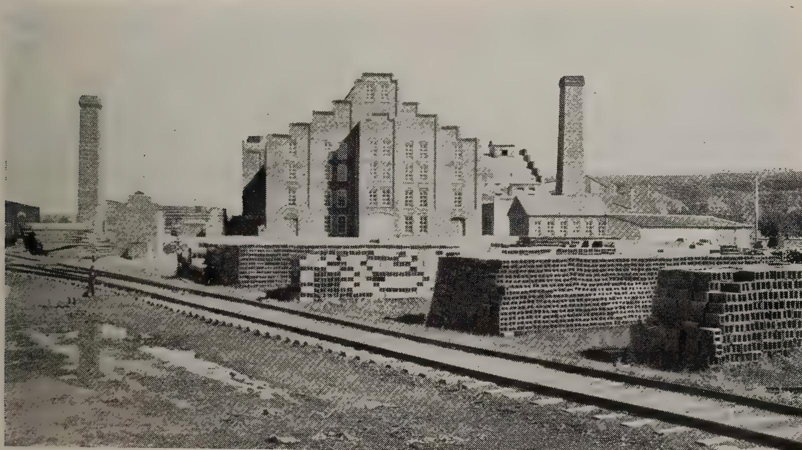

Fig. 5.—Works of the Alberta Clay Products Company, at Medicine Hat, Alta.

no permanent kiln buildings, the clamp or scove kiln being generally set up for each burning. These plants operate about six months in the year, the output varying from 500,000 to 3,000,000 bricks for this period.

Plants with a large output can only be operated successfully when located conveniently to a large market. Most of the common brick plants producing 8,000,000 to 22,000,000 brick per year are situated in close proximity to the larger cities. They are equipped with several brick machines, artificial driers, and permanent down draft or continuous kilns.

Plants producing dry pressed and plastic bricks made from shales, involve a much larger expenditure of capital than those operating on surface clays. Shale bricks plants must be equipped

with grinding machinery, stiff mud or dry press machines, artificial dryers, and permanent kilns. The power necessary to drive a shale brick plant is a costly item of installation and maintenance.

A notable group of recently erected shale brick plants are those located at Laprairie and Delson Junction on the south side of the St. Lawrence River, fourteen to eighteen miles from Montreal. There are three plants of the National Brick Company and one of the St. Lawrence Brick and Terra Cotta Company. They produce stiff mud, tapestry, dry pressed and enamelled bricks from the red burning shale of the Utica-Lorraine formations. The output of the combined plants is about 700,000 bricks per day, and operations continue for about ten months in the year.

There are several shale brick plants in the vicinity of Toronto, the Don Valley Works being the oldest and largest. This plant

Fig. 6.—Clay bank of the Alberta Clay Products Co., at Coleridge, Alta.

produces stiff mud bricks from surface clay and dry pressed bricks rom the Hudson River shales, the total output exceeds 25,000,000 during the season.

There are two brick plants in Manitoba using shale, one at Leary where a red dry pressed brick is made from Niobrara shale and another at LaRiviere, where the Pierre shale is used. These shales belong to the upper part of the Cretaceous system.

The Estevan Brick Company make red dry pressed bricks from soft shale underlying a seam of lignite. This is the only plant at present of this kind in Saskatchewan.

There are six shale brick plants in operation in the province of Alberta. These are located at Medicine Hat, Red Cliff, Brickburn near Calgary, Sandstone, Blairmore, and Edmonton. They all make red bricks only, except at Red Cliff, where a limited number of buff bricks are produced from a special seam of clay shale. The

Medicine Hat and Red Cliff plants burn with natural gas, the others all use either bituminous coal or lignite for fuel.

The only shale brick works operating at present in British Columbia is situated at Clayburn, close to the Sumas mountain. A fine rich buff colored facing brick, as well as red brick are produced here.

The plants at present under construction which will place bricks on the market for the season of 1913, are located as follows:—At Montmorency Falls, about six miles from the city of Quebec, to use the Lorraine shale. At Russell, Cooksville and Meaford in Ontario. Two new shale brick plants are being operated on the islands in the vicinity of Victoria, B.C., and shale brick plants are being erected at Calgary and Edmonton in the province of Alberta.

Paving Brick

These are at present produced at only two points in Canada. One plant located at West Toronto and using Lorraine shale, which

Fig. 7.—Unworked deposits of Cretaceous shales at Entwhistle, Alta., near line of the Grand Trunk Pacific Railway

is mixed with a small proportion of surface clay, and one at Clayburn, using Tertiary shale of Sumas mountain. A plant is being erected at Calgary, which will make this class of wares.

Fire Brick

These are made at only one point in Canada, at Clayburn, B.C. A semi-refractory brick is made at Westville, Nova Scotia, from a bed of Carboniferous shale underlying a coal seam. They are used at the steel works in Sydney, being found satisfactory as a lining for ladles into which the molten steel is poured from reverberatory furnaces.

Fire bricks and special shapes of refractory goods are made at the Standard Drain Pipe Company's works at St. Johns, Quebec, and at the works of the Montreal Fire Clay Company, but their clay is brought from the state of New Jersey in barges.

A brick plant is being erected at a point in the Dirt Hills, Sask., about twenty-five miles south of Moosejaw, where it is proposed to manufacture fire brick.

Sewer Pipe

The plants producing sewer pipe in Canada are located at New Glasgow, Nova Scotia, St. Johns, Quebec. Toronto and Hamilton in Ontario, and at Victoria, British Columbia. A mixture of Carboniferous shale is used at New Glasgow, and gives good results. At St. Johns a certain proportion of fire clay brought from New

Fig. 8.—Dry pressed brick plant at Blairmore, Alta., bank of Cretaceous shale in rear

Jersey is mixed with surface clay obtained close to the works. The greater part of the body is composed of the surface clay. The fire clay acts as a skeleton or "stiffner" to hold the surface clay under fire. The Ontario plants use the red Medina shale, obtained from Waterdown, near Hamilton. At Victoria, a mixture of surface clay and fire clay from Kuyoguot is used.

A plant is being erected at Calgary for the manufacture of sewer pipe, and this company expect to have their goods on the market early in the season of 1913.

Fireproofing

There is only a meagre production of this desirable class of clay products in Canada. A branch works of the National Fireproofing

Company of the United States is located at Waterdown, four miles from Hamilton. A large part of the output of this plant is sold in Toronto. The material used is weathered Medina shale.

The Alberta Clay Products Company at Medicine Hat, produce annually, a large quantity of fireproofing. The clay is obtained from selected beds in the soft Cretaceous rocks which occur so abundantly in this region. The burning is done with natural gas, furnished free from the municipal wells.

INSTRUCTIONS RESPECTING WATER POWERS

By A. V. White, M.E., '92

In the summer of 1911 the Commission of Conservation, Canada, commenced an investigation in British Columbia respecting the inland water resources of that Province. The work was continued during the season of 1912. This investigation permits the use of reconnaissance methods, by means of which knowledge may quickly be had respecting the general character, magnitude, and locations of the water-powers of the country.

The need of some brief statement setting forth some of the fundamentals which should govern in the gathering of the water power information has often presented itself in connection with the work. To meet this urgent need arising in connection with the research, a pamphlet was prepared by the writer to act as a guide to those who may be interested in the collection of preliminary data relating to these inland waters. The following article is extracted from the pamphlet referred to and contains a few suggestions of probable interest to the majority of engineers.*

Guiding Principles

In order to assist to a better appreciation of the general subject of water conservation, it is deemed profitable here to make a few remarks along the lines laid down in a recent report of the Commission of Conservation of Canada, entitled "Water Powers of Canada." This report, which is freely quoted in what follows, points out that precipitation by rainfall, or snowfall, virtually constitutes the only source of inland water supply. Speaking broadly, of the annual precipitation upon the earth, about one-half is evaporated; about one-third is "run-off"—that is, it runs off over or through the ground, and eventually reaches the sea; and about one-sixth either joins the ground water, or is taken up in plant structure, or is otherwise absorbed in processes incident to the ground. The natural and cultivated properties of the land on which the rain and snow fall largely determine the efficient uses to which precipitation is applied.

* This pamphlet is entitled *Instructions relating to the gathering in the field of certain Preliminary Information relating to Water Powers*, by Arthur V. White, and published by the Commission of Conservation, Ottawa, 1912. The pamphlet draws attention to the fact, that while it is intended to be of service to engineers, nevertheless one of its chief objects is to acquaint road inspectors, timber cruisers, forest rangers, fisheries inspectors, and others, with the principles underlying an intelligent investigation of inland water resources. Ed.

It is in this connection that forests are so indispensably associated with the precipitation, and hence with water as a natural resource. Whatever opinion may be entertained respecting the effect of forests in influencing the amount of precipitation, the burden of opinion is that no feature of the topography of the country ministers more efficiently to the gradual and economical run-off from the precipitation than do forest areas. Thus it is that failure to intelligently conserve forest areas has wrought havoc by causing a great destruction of forest floors and agricultural lands, which, humanly speaking, can never be restored, to say nothing of the annual destruction to property by flood run-off, which seems yearly to increase rather than diminish. The run-off is the chief factor entering into water-flow problems as they relate to power development.

A deforested, eroded, and scoured territory, which has lost the humus of the soil, cannot retain the beneficent rains which, instead of being retained in the ground and transmitted into plants by the various processes of growth, carry destruction in the pathways of their torrential run-off. The water is necessary to the soil, and the soil, with its plant growth, is necessary to an economical disposition of the water. The interests of municipal and domestic water supply, water for manufacturing and industrial purposes, irrigation, navigation, and water power are all interrelated and interdependent. They all depend on the same natural source—precipitation.

In the case of water power developments, therefore, it would be well to consider whether or not the industries which might use the water powers would prove to be a menace to the district of their proposed location, and thereby spoil the watershed or waters for other necessary uses. Thus, wood-pulp mills, for example, which might completely denude the timber lands of trees at or near the headwaters of important waterways had better not be established at all; or if established, then only under the strictest regulation and supervision designed to conserve the forest growth.

Along this line, therefore, in some instances, it may be possible for the engineer, or observer, when making his observations, to indicate what he thinks this or that particular water-power might be used for; whether, we shall suppose, for municipal purposes to serve a neighboring town or settlement, for mining, for manufacturing wood pulp, or, etc. Sometimes some such remarks prove to be suggestive to persons seeking opportunities for industrial development.

Pollution by Factory Wastes

The effects likely to result from the pollution of waterways by the waste products emitted from the industries utilizing power from these waterways are also very important factors for consideration. The maintenance of a pure and sufficient domestic water supply is a vital consideration; and, hence, a class of industrial waste products that will destroy life in the waters into which they are turned must be regarded seriously in their probable influence on human life. If any special instances of stream pollution are observed, it would be well to make a memorandum of such facts. When one

realizes how even a great waterway like the Great Lake system has been polluted, too great caution can hardly be exercised to conserve the purity of our inland waters.

Water-Powers Require Classification

The amount of water-power is determined by two factors; first, the hydrostatic head, or the vertical distance through which the water may fall; and, second, the amount of water which may be made to operate upon the water-wheels. There are, however, many characteristic features associated with water-powers, which differentiate one power from another, and which determine the commercial and economic values of the individual powers. It is as unreasonable not to differentiate between water powers as it would be not to differentiate between timber tracts, mineral lands, or the items of any other natural resource varying in quantity, quality, and situation.

In presenting water power information, effort should be made to make brief remarks upon features which may have special bearing upon any specific possible power sites.

By way of illustration, it may be remarked that the St. Lawrence River, owing to the vast storage capacity of the natural reservoirs found in the Great Lakes, has the most uniform flow of any large river in North America, or, probably, in the world. Therefore, other conditions being equal, water-power developments on this river will be of very much greater value than developments on a river subject to such great variations of flow as take place, for example, on the Mississippi. Inasmuch, therefore, as the uniformity of the flow of water greatly affects the values of water-powers situated upon various water-courses, it would be fitting for the observer, or engineer, to note any features that might appear capable, or appear to be made capable, of contributing towards uniformity of stream flow.

Reservoir Sites

In connection with the subject of uniformity of flow, one may be on the lookout either for natural reservoirs, such as lakes, or river expansions, or for natural sites where reservoirs may be created by means of dams. In such reservoirs the run-off from precipitation may be impounded, and subsequently discharged gradually throughout the year. Water-powers situated within the range of the direct influence of such natural storage reservoirs may be of incomparably greater value than other water-powers not so favored.

When the subject of storage reservoirs is under consideration, it should not be forgotten that Nature also stores her waters elsewhere than in lakes and rivers. Forest floors, extensive areas covered with plant growth, soils and sub-soils, the gravel-beds of streams, and the great swamps of the country, each and all, constitute valuable water reservoirs. In such reservoirs there is a widespread and satisfactory distribution of waters, which enables Nature to yield her supplies gradually and as required. A discreet conservation and utilization of such reservoirs will, in general, be found to be much

more desirable than some of the large artificially constructed reservoirs, where the liability of accidental destruction of large construction works is always more or less of a menace.

In passing, it may be noted that where an early selection of reservoir sites is made, and the same held under Government control, so that no settlement, railway construction, or other similar improvements, is allowed to take place upon such reservoir sites, the expense and trouble incident to future reimbursement for expropriated properties will be avoided. Hence the desirability of the Government having knowledge of the existence of such sites.

Actual Measurements Required

When information regarding water-powers is to be gathered, it is extremely important that the data be sufficient, and of the class that will enable a sound opinion to be formed upon the general water interests involved.

But little confidence can be placed in any reports of water-powers not based upon actual measurements, for, without measurements, the best judgment of explorers, and even engineers, as to the heights of falls and the amounts of water discharging over them, is frequently very wide of the results disclosed by actual measurements.

This is well illustrated by an experience related by the engineer in charge of much of the field work of steam-gauging for the Hydro-Electric Power Commission of the Province of Ontario. This engineer stated that prospectors who had been at the falls on the Kawashkagama River told him, in good faith, that the falls were capable of developing 30,000 horse-power at low water; and he was further assured by a surveyor, who claimed familiarity with what he was speaking about that the Kawashkagama River was able to yield as much power as the Kaministikwia River. After a hard journey, the engineer arrived at the falls, and, instead of the 30,000 horse-power reported found the 317 horse-power given for the Kawashkagama River in the report of the Hydro-Electric Power Commission! If these prospectors had published a report of their mining or geological investigations, and incidentally mentioned that 30,000 horse-power could be developed at low water on the Kawashkagama River, such an assertion would have been very misleading.

Reconnaissance Surveys

When the knowledge of the quantities of water-power that may be available in particular places is required on short notice, and when sufficient records of actual observations do not exist, it is possible to estimate the probable amounts of power available. For such preliminary estimates, data are secured by what may be termed a reconnaissance survey of the general situation; but it must be recognized that the conclusions reached by such methods are not comparable with the results deducible from actual observations

of individual water-power conditions extending over a series of years.

It will be profitable to explain, very briefly, these reconnaissance methods for estimating water-power. First, the area of the watershed in question is ascertained by measurement from the best available maps; to this area is applied an assumed run-off coefficient such as would be suggested by a general knowledge of the precipitation, and of the topography, and other characteristics of the territories involved. The wise choice of the coefficient used will, of course, depend upon the good judgment and knowledge possessed by the engineer. This run-off coefficient, as it is termed, is a quantity which represents the amount of water that may be drained off any specified area during a stated period, and is usually expressed as so many cubic feet per second per square mile. Obviously, if the area of the watershed is known to be so many square miles, and each square mile, under specified conditions, will yield so much water, then the total yield of water from the whole watershed will be the product of the factors just mentioned.

When the discharge of a stream, or river, is actually measured, it is usually accomplished by means of floats, or by using a current-meter. The principles involved are very simple. They consist essentially of measuring the velocity of the flow of the stream by means of floats, or meter, and measuring also the area of the cross-section of the river at the place for which the velocity has been thus obtained. The volume of the water which passes a given point is the product of the area of the cross-section of the stream and the velocity of flow at that point.

A concrete illustration will make these methods of estimating clearer. Take, for example, the case of a water-power like Healey Falls, on the Trent River, Ontario. The fall is here considered to have an effective head of 60 feet, and we will further suppose that it is desired to ascertain the horse-power available at low water. From the map of the district it would be ascertained, by measurement, that the drainage area above the fall is about 3630 square miles. If the engineer had previously ascertained that the run-off in some other similar territory was .4 cubic feet per second per square mile, he would use this co-efficient and thus obtain an estimated run-off, or discharge of 1,452 cubic feet of water per second (3,630 square miles x .4). Assuming water-wheels of 80 per cent. efficiency, this 1,452 cubic feet of water per second, with a fall of 60 feet, would give approximately 8,000 horse-power. If actual, yet insufficient, discharge measurements were made at Healey Falls, such data would be criticized by the engineers according to the time of the year at which they were made, etc., in order to deduce what the Trent River would discharge at its lowest stage; and this quantity, so derived, would then serve as a check upon the flow estimated by means of the previously assumed run-off coefficient and drainage area.

Estimating the Horse-Power

The theoretical horse-power available at any point on a stream is the product of the effective height through which the water falls, and the weight of the water falling in a given time. Thus:

Let Q represent the flow of water in cubic feet per second,
h represent the effective fall in feet.

$$\text{Horse-power } \frac{5\,Qh}{44}$$

Considering a good turbine to develop 80 per cent. of the theoretical power, we have

$$\text{Horse-power } \frac{Qh}{11}$$

Hence, a simple rule for estimating the horse-power that may be developed under favorable conditions is: *Multiply the flow in cubic feet per second* (Q) *by the effective head in feet* (h), *and divide the result by 11.*

It must not be forgotten that, in order to state in a reliable manner the power available for any place, it is necessary to give the stage of the river (namely, the height of the surface of the river with respect to a zero or bench-mark), at which the amount of power stated may be produced.

Certain Data Indispensable

When the data collected is published it will be presented in tabular form, so as to be convenient for ready reference. The information communicated by engineers and others should, therefore, always be of a character that permits reduction to tabular form. The essential facts required to be known in every instance are:

(1) Name of river upon which the fall, rapid, or canyon is located:

(2) Local name of fall, rapid or canyon:

(3) Description, giving location of fall, rapid, or canyon (if adjacent to a branch of a stream, state definitely whether power-site is on main river or on the branch, and where:

(4) What total head in feet is obtainable at the site mentioned, and how is the head made up? That is, what portion of the head is direct fall, what portion rapids, and, about, in what distance does the drop, or fall, in any particular rapid occur?

(5) How is the head measured?

(In the pamphlet of instruction there follows at this point a tabulated series of questions and supposititous replies to same, also a table representing how the data supplied by field observers will appear when published. Ed.)

Floats

When floats are utilized for the direct measurement of the velocity of streams, those in common use are surface, subsurface, and tube- or rod-floats.

Subsurface-floats.—The subsurface-float is designed to measure velocities below the surface and may be made to float to any depth. By arranging the submerged float at the depth of mean velocity, it may be utilized in observing mean velocity directly. Allowance must be made, however, for the accelerating effect of the attached line and surface-float.

Tube- or Rod-floats.—The tube- or rod-float is designed to measure directly the mean velocity in a vertical. It is generally a cylinder of tin, about 2½ inches in diameter, weighted at its lower end and plugged with wood or cork at its top. Small extra weights to make it float at the exact depth desired may readily be added by admitting water or by putting in shot. The tube should be graduated and alternate feet painted black and red in order that the depth of the flotation may readily be observed.

A number of tubes, of different lengths, are necessary for measuring the velocity of different depths in an ordinary cross-section. A float of this type, consequently, is best adapted for use in artificial channels in which the depth is nearly uniform. Natural channels are generally too rough and too variable to permit of satisfactory use. In field-work, where it appears expedient to employ rod-floats, these may be improvised by using dry saplings, cut to suitable lengths and weighted with stones tied to their lower ends.

Although designed to measure directly the mean velocity in a vertical, the tube cannot be made to float in contact with the bed of the stream, and, consequently, it does not receive the effect of the slowest moving water. The rougher the bed the greater the error in this respect. A factor less than unity is, therefore, necessary to reduce the observed velocity to the mean.

Memoranda Regarding the Determination of Approximate Stream Discharge by Surface Floats*

Although the method of determining the discharge of streams with floats is not usually so convenient, or simple, as with the current-meter, it is, however, less expensive, and for all practical purposes, especially in reconnaissance work, the results are quite as good as those obtained with the current-meter, provided the measurements are not to be used in conjunction with daily gauge heights in order to determine the daily discharge.

To determine the discharge by means of floats, select a straight course along the stream in question, the length of the course being, roughly, about twice the width of the stream. The cross-section throughout this course, and for a short distance above and below it, should be as uniform as possible; and the bottom should be as smooth as possible and free from all large projections. Rather than run floats over bad reaches in the stream, it is preferable to shorten the course, although it is rarely desirable to take a course less than 50 feet in length, unless the stream is less than 10 to 20 feet wide.

*The data respecting stream measurement by surface-floats, here given, have been furnished as a result of special research made by Mr. R. H. Bolster, and have been made available, for present purposes, by the courtesy of Mr. M. O. Leighton, Chief Hydrographer of the United States Geological Survey.

At the upper end of the course set two rods, rod 1 on the river bank, and rod 2 about 50 to 100 feet back from the river, so that a line through them will be, as nearly as possible, at right angles to the direction of the stream over the selected course. Carefully measure the distance from rod 1, located nearest the river, to the lower end of the course, and there locate rod 3 at an equal distance back from the river. Going next back from rod 3 the same distance (measured) that rod 2 is from rod 1, locate rod 4, which should be exactly the same distance from rod 2 as rod 1 is from rod 3. NOTE.—In very narrow streams, rods 2 and 4 can frequently be dispensed with, but in wide streams they should always be used.

Have an assistant loosen floats,[1] consisting of small blocks of wood (weighted, if necessary, to avoid wind effect on the surface exposed above the water), a short distance above the upper end of the course, spacing them across the stream at intervals of about one-tenth the width of the river. Sight past rods 2 and 1 and note with a stop-watch,[2] or an ordinary watch, the time when a float passes the upper end of the course. Go to the lower end of the course and similarly note the passage of the same float past staffs 3 and 4. The average of time the float runs, divided into the distance apart of the upper and lower ends of the course, will give the average surface velocity in feet per second.

Determine four cross-sectional areas (or more if desired), located at 1-8, 3-8, 5-8, and 7-8 the distance between the upper and lower ends of the course. Stretch a tagged telegraph wire, measured cord, or steel tape across the river at the points indicated, and, at regular intervals, take soundings, recording them as indicated in the table below. Ten sounding points, equally spaced, should ordinarily be sufficient.

Cross-section One-eighth Below Upper End of Course

Station.	Depth in Feet.	Width in Feet.	Mean Depth in Feet.	Area in Square Feet
12	0.	..	..	..
20	1.1	8	.6	4.8
30	4.3	10	2.7	27
40	5.6	10	5.0	50
50	6.3	10	6.0	60
60	7.6	10	7.0	70
70	7.0	10	7.3	73
80	6.1	10	6.6	66
90	5.3	10	5.7	57
100	4.0	10	4.6	46
110	2.1	10	3.0	30
117	0.	7	1.0	7
			Total area,	491

1 A corked-bottle float, with a flag in the top and a weight in the bottom, makes a very satisfactory surface-float, as it is but little affected by the wind. In flood measurements good results can be obtained by observing the velocity of debris, or of floating cakes of ice.

2 Stop watches are necessary for the satisfactory observation of velocity by floats, and for integration by meters. They are recommended for use in all meter-work.

Total area at ⅛ point	491
Total area at ⅜ point (here assumed to be)	500
Total area at ⅝ point (here assumed to be)	458
Total area at ⅞ point (here assumed to be)	511
Total	1,960
Average cross section	490 square feet

The average of the four areas can be taken as the average cross-sectional area of the course. The soundings can be made by wading the section with a graduated rod, or from a boat with graduated rod, or with weight on the end of a graduated cord, if too deep for wading. The tagged wire can be used to hold the boat in position.

The mean surface velocity (feet per second) **x** the mean cross-sectional area (square feet) **x** a constant K = the discharge of the stream in cubic feet per second.

The constant K varies quite widely under different channel conditions, ranging from a minimum of about .70 to a maximum of about .90 or more. In general K can be said to vary inversely as the slope (or velocity), inversely as the roughness, directly as the depth and indirectly as the width (for narrow streams).

The following table will serve as an approximate guide in the determination of the most probable coefficient K. Interpolate for conditions not given in the table.

Velocity (Feet per Second)	Average Depth (Feet)	Size of Material on Bottom (Feet)	Coefficient
2 or less	2 or less	½ or less	.80 to .85
2 or less	2 or less	1	.75 to .80
5	2 or less	½	.80
5	2 or less	1	.75
10 or more	2 or less	½	.75
10 or more	2 or less	1	.70
2 or less	5	½ or less	.85 to .90
2 or less	5	1	.85
2 or less	5	3 or more	.85
5	5	½ or less	.85
5	5	1	.85
5	5	3 or more	.80 to .85
10 or more	5	½ or less	.80 to .85
10 or more	5	1	.80
10 or more	5	3 or more	.80
2 or less	15	½	.90
2 or less	15	1	.90
2 or less	15	3 or more	.90
5	15	½	.90
5	15	1	.90
5	15	3 or more	.85 to .90
10 or more	15	½	.90
10 or more	15	1	.85 to .90
10 or more	15	3 or more	.85 to .90

The coefficient close to abutments, or piers, usually lies between .90 and 1.00, and is often greater than unity. Similarly for channels with rectangular sides and a width not greater than about three times the average depth, the coefficient is likely to be higher than .90 and sometimes greater than unity.

Convenient Equivalents

The following is a list of convenient equivalents for use in hydraulic computations:

In British Columbia, under the "Water Clauses Consolidation Act, 1897," section 143, one miner's inch was declared to be a flow of water equal to 1.68 cubic feet per minute.

Therefore, one miner's inch = .028 cubic feet per second, and one cubic foot per second = 35.7143 miners' inches, approximately.

A flow of one miner's inch per second = 0.1745 imperial gallons per second.
1 second-foot equals 40 California miners' inches (law of March 23, 1901).
1 second-foot equals 38.4 Colorado miners' inches.
1 second-foot equals 40 Arizona miners' inches.
1 second-foot equals 7.48 United States gallons per second.
1 second-foot equals 6.2321 imperial (British) gallons per second.
1 second-foot for one year covers 1 square mile 1.131 feet, or 13.572 inches, deep.
1 second-foot for one year equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one day covers 1 square mile 0.03719 inch deep.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet.
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre feet.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-feet per year.
1 foot deep on 1 square mile equals 0.88 second-feet per year.
1 mile equals 5,280 feet.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 cubic foot of water weighs about 62.5 pounds.
1 horse-power equals 550 foot-pounds per second.
1 horse-power equals 746 watts.
1 horse-power equals 1 second-foot falling 8.80 feet.
1 1-3 horse-power equal about 1 kilowatt.

To calculate water-power quickly: $\frac{\text{Sec..-ft.} \times \text{fall in feet}}{11}$ = net horse-horse-power on water-wheel realizing 80 per cent. of theoretical power.

C. Hughes, '09, is engineer-in-charge of surveys for the St. John & Quebec Railway at Fredericton, N.B.

J. S. Parker, '11, is at Burks Falls, Ont., as mechanical engineer in charge of power equipment for the Knight Lumber Company.

F. A. Dallyn, '09, of the Ontario Board of Health, is collecting data concerning the water in Lake Huron, Lake St.Clair and River St. Clair, for a report to be presented to the International Joint Commission, relative to lake pollution.

BITUMEN IN MODERN PAVEMENTS

By J. B. Temple, B.A.Sc.

Part II

In the closing paragraphs of the preceding part of this article a short historical treatment of sheet asphalt was given together with an illustration of the important part which the temperature range plays in the formulae for a pavement.

The materials composing a sheet asphalt wearing surface are a uniform mixture of asphaltic cement, a mineral aggregate (consisting of sand) and a mineral dust filler (pulverized limestone).

[1]"The materials shall be mixed in the following proportions by weight:—

Asphaltic cement	10 to 18 per cent.
Sand	85 to 67 per cent.
Mineral dust	5 to 15 per cent.

"The refined asphalt shall contain no admixture of coal tar, coal tar products, or any inferior bituminous matter.

"The flux used in the manufacture of the asphaltic cement shall be either liquid asphalt or maltha, asphaltic petroleum residuum, paraffin petroleum residuum or other softening agent from which the lighter oils have been removed by distillation without cracking until the flux has the following characteristics: Specific gravity .924 to 1.05 at 78 deg. F. Flash point not less than 325 deg. F. in a New York State closed oil tester. It shall not volatilize more than 5 per cent. at 325 deg. F. in seven hours. When the refined asphalt is not already of the proper consistency the cement shall be prepared by tempering the asphalt with the flux as above specified in proportions approved by the engineer. They shall be melted together and thoroughly agitated by approved appliances until they are completely blended into a homogeneous asphaltic cement. The agitations shall be continued until the cement is used and the cement shall never be heated to a temperature exceeding 325 deg. F."

It is also required in these specifications that the sand be sharp and clean, that the whole of it shall pass a 10 mesh sieve, 15 per cent. an 80 mesh sieve, and at least 7 per cent. shall pass a 100 mesh sieve. In the case of the pulverized limestone it is required that 80 per cent. pass a 200 mesh sieve.

The exact proportioning of the above materials is determined by the engineer and depends upon conditions before mentioned. The point sought for is to produce the densest mixture practicable. However, the bituminous matter soluble in carbon bi-sulphite in any pavement is never less than 9 per cent., nor greater than 12 per cent.

The sand and the asphaltic cement are heated separately to approximately 325 deg. F., and are mixed along with the mineral

* City of Toronto revised specifications, Sept. 1911. See D-6.

dust in an asphalt mixer, which is designed to agitate the material until a thoroughly homogeneous mass is produced. Provided the above has been successfully carried out the asphalt is ready to be carted in covered waggons to the street under construction.

It has been the custom in most cities of late to lay the asphalt on a binder which consisted of broken stone slag or gravel not exceeding 1½ inches heated and mixed with hot asphaltic cement in proportion of 15 gallons of latter to 1 cubic yard of stone.

This binder was spread and rolled to the depth of 1 inch on top of the concrete sub-grade and the idea was that the hot asphalt would penetrate the voids and (the binder being plastic) it would prevent the surface from "creeping" away from the foundation.

Most of the bulging, rolling and cracking of the surface was attributed to this creeping or the parting of the asphalt from the concrete foundation. Although this binder has come into general use there are many authorities that claim that it will not hold the surface mixture from undue movement and is of no particular value. So far it is just a case of argument, but good engineering practice seems to favor this bond between the surface mixture and the concrete. To ascertain its value experiments are now being carried on in Houston, Texas. Several surfaces have been laid on the rough concrete which was previously coated with a mixture of asphaltic cement.

Up till two years ago all sheet asphalt pavements were laid in Toronto directly upon the concrete foundations, but as the binder was heralded as a "Cure All" for paving defects, there have hardly been any pavements laid of late without it. However, its use is yet in the experimental stage.

Before the surface mixture is placed all contact surfaces of curbs, gutters, manholes, joints, etc., must be painted with hot asphaltic cement. The asphalt should reach the street at a temperature ranging from 250 deg. to 350 deg. F., and is spread to the required depth (1½ to 2 inches) with hot rakes. It is then compressed with a hand roller, after which hydraulic cement or pulverized limestone is swept over it, and as soon as the material will bear it, it is rolled with a steam roller (at least 5 tons in weight). Places not accessible with the roller are thoroughly tamped with hot irons made for that purpose. It is an important point that all contact surfaces should be perfectly dry.

Asphalt Block

Asphalt blocks have been used extensively of late on both residential and heavy traffic streets. This class of pavement possesses several advantages over sheet asphalt. Among others it requires no special plant near the work. This is an advantage

to small towns that have not enough paving work to keep a plant running. An asphalt block pavement is also easily repaired and shares most of the good points of a brick surface, but is not so noisy or dusty. If placed upon a solid concrete foundation it is somewhat more permanent than sheet asphalt and will not crack nor be so slippery. As asphalt block pavement wears, the corners and sharp edges get broken and it presents a rather rough surface. Therefore it is advantageous to lay out this pavement with a rather higher crown than sheet asphalt. One great disadvantage against the common use of this pavement is the first cost. In Toronto it costs $3.80 to lay a square yard of block on 5 inches of concrete, as contrasted with $2.00 for sheet asphalt on the same depth of foundation.

Asphalt blocks are composed of asphaltic cement, crushed trap rock and inorganic dust. The blocks contain from 6 per cent. to 8 per cent. bitumen and the remainder is the mineral aggregate, the coarsest particles, which are not larger than ⅜ in., down to the fine dust or filler composed of limestone or cement or a mixture of the two.

In the manufacture of the blocks the trap rock is first crushed and screened. The different sizes are then proportioned by weight and are mixed in a mixer with hot asphaltic cement (300 deg. F.). The result of mixing the asphaltic cement with the dry mineral aggregate produces within two or three minutes an absolutely homogeneous mass. This is then conveyed to the mold boxes, where a pressure of one hundred and twenty tons is applied to the top, bottom and two sides of the block by four springs. It is then discharged, examined, and if up to the standard, is placed on a conveyor and cooled by passing through water. By this method one batch of 1,500 pounds from the mixer will make 70 to 80 blocks, and a plant with five mold presses has a capacity of from 20,000 to 30,00 blocks a ten-hour day.

Various physical and chemical tests are made upon asphalt blocks to determine their probable efficiency. The principal physical ones are breaking, rattler, and impact tests, while the main chemical one is the extraction of the bitumen.

The breaking test is similar to the one used in concrete. The block is placed (widest face uppermost) on two lateral supports which are equidistant from the middle and pressure applied (at the middle) across the entire width by the passing down of a wedge-shaped piece of cast iron. The amount of pressure required to break the block is automatically registered.

The block that gives the highest value in this test is not always the best, for this value depends on the hardness of the asphaltic cement, and it is often desirous to have a relatively soft cement.*

*Howard Hottel in "*Contract Rceord*," August 2, 1911

The impact test is supposed to represent the blows of traffic. The block is firmly placed upon a cement base and the blow delivered through a spherical end plunger resting upon the centre of the widest face of the block, and the latter is adjusted so that the spherical end of the plunger is pressed firmly upon it by two spiral springs.

The blow is struck by a hammer weighing 2 kilograms, which is raised by a rope and pulley, and released automatically. The test consists of 1 cm. fall of the hammer for the first blow and an increased fall of 1 cm. for each succeeding blow until block breaks, and the number of blows required to do this represents the toughness.

The rattler test is supposed to represent the wear and tear upon a pavement from horses' hoofs and waggon wheels. It consists of placing 18 to 20 blocks in an iron shell which is made to revolve. After the blocks are tightly wedged in so that they won't move, and so that they present a level surface, a shot charge of 50 pounds of 2½ in. castiron cubes, having sharp corners and weighing about four pounds each, is put in the rattler. The cover is placed on and the machine is revolved at the rate of 37 revolutions per minute.

The revolutions of the rattler are recorded automatically upon a dial, and one test consists of 10,000 revolutions. The average loss per cent. of weight by this test will be about 8.7 per cent. or will run from about 7.02 per cent. to 10.98 per cent.

The amount of bitumen present is obtained by extraction with either cold carbon bisulphite or hot benzol. In the former test the mixture and carbon bi-sulphide are placed in a pair of revolving cones separated by a felt ring.

As the cones are swung at high velocity in a small centrifugal machine, the solvent filters through this felt ring. The operation is repeated until the filtrate comes through clear.

The latter method consists of placing the material in a soxhlet apparatus and making a continuous extraction with hot benzol.

The analysis of a block picked at random is given by H. C. Hottel as:—

Size, 12x5x3 inches.
Weight in air, 15 lbs. 7 ozs.
Weight in water, 9 lbs. 4 ozs.
Specific gravity, 2.5.
Impact at 77 deg. F., 46.
Bitumen, 7.3 per cent.
Passing 200 mesh sieve, 17.1 per cent.
Passing 80 mesh sieve, 4.0 per cent.
Passing 20 mesh sieve, 6.3 per cent.
Passing 10 mesh sieve, 12.0 per cent.
Passing 4 mesh sieve, 28.0 per cent.
Retained on 4 mesh sieve, 2.0 per cent.

Specific gravity of mineral aggregate, 2.92.
Penetration of asphalt cement, 30 cm.
Average loss in rattler, 7.5 per cent.
Ductility of asphalt cement, 15 cm.

The passing of the mineral aggregate through the screens determines whether it is graded properly, and the amount of bitumen, the density of the block and the density of the mineral aggregate give the per cent. of voids present.

The blocks are laid upon a solid cement foundation (5 or 6 in.), which conforms to the shape of the finished road. Upon this foundation is placed about one-half inch of slow setting cement mortar made in the proportion of 1 part cement to 4 of clean, sharp sand entirely free of pebbles over one-quarter of an inch. This mortar cushion must be struck off true to the cross section and present a perfectly smooth surface and in no case shall the mortar cushion be laid so far in advance of the pavers as to allow the initial set to take place before the blocks can be laid.

Upon this mortar surface the blocks are immediately laid with close joints and uniform surface, the pavers standing upon the blocks already laid and not on the bed of mortar. The blocks are laid at right angles to the curb except at street intersections where they are placed diagonally and the longitudinal joint should have a lap of at least four inches.

When the blocks are laid with all joints tight as possible, the pavement is rolled or rammed and flooded with water and the filling applied. This grout filler is applied in two operations. In the first the mortar is much thinner than in the second, and is composed of one part cement and one part sand. It is mixed in a box, carried to the pavement in scoop shovels and rapidly swept into the joints till they are about half-full. In the second operation the grout is thicker and is composed of two parts cement and one part of sand. It is applied till all the joints are full and a surplus shows on top of the block pavement.

Creosoted Wood Block

Creosoted wood blocks have many advantages that recommend them for some classes of work as an almost ideal pavement. They are noiseless, elastic, somewhat dustless, and present good footing for traffic. They are also easy to handle and quickly laid.

Past experiences with wood as a paving material had been somewhat disappointing and even the first creosoted blocks were not very durable, but as methods of manufacture improved, the durability and adaptability of the blocks improved probably more than 100 per cent.

In common with other block pavements, the maintenance

cost is light, as it requires no special plant or tools for repair work.

The great disadvantage with creosoted wood block is the cost, which is now a trifle more (in Toronto) than a first class asphalt block, and on account of the ever-increasing scarcity of suitable timber this price will always keep advancing. This is a serious drawback for its extensive use in the future. The woods from which the blocks are generally made are sound long leaf yellow pine, Oregon or Douglas fir and several other trees of this type. It is absolutely essential that the timber from which the blocks are sawbutted shall be sound and free from coarse knots, worm holes, decay, bark, etc.

The blocks are manufactured truly rectangular and uniform and dressed on all sides except the top and bottom. They are then placed in an iron cylinder and sterilized by steam at about 250 deg. F. and 40 lbs. pressure for at least 3 hours. All fluid matter is drained from the cylinder and a vacuum pump set to work which produces a vacuum of at least 24 inches, the wood blocks being kept hot the while by means of steam coils in the cylinder. Creosote oil conforming to the required specification is then run in at a temperature between 180 deg. F. and 200 deg. F., and maintained under pressure till the blocks contain at least 18 pounds of creosote oil per cubic foot of wood. (This is somewhat modified for woods containing a great deal of natural pitch.)

In J. W. Howard's "Standard Specifications for Creosoted Wood Block Pavement" several tests for the materials are also described, the most important for the finished block being the indentation or pressure test, which is in brief as follows:—

"The blocks are dried at 100 deg. F. for 12 hours, then a polished steel die of 1 sq. inch on its lower face, square edges, corners, and perpendicular sides, is placed on a dried block firmly supported in a compression testing machine. A pressure of 8,000 pounds is applied quickly and maintained exactly one minute. The die must not descend and indent the block more than one-eighth of an inch.......... The die is placed anywhere within one-half inch of the edges of the block and so as to compress lengthwise the wood fibres."

It is also noted that a block dried as above should not absorb more than 4½ per cent. of water. The methods of laying are very similar to those described for asphalt block. Expansion joints varying from ¾ to 1 inch are constructed between the curb and the wood paving blocks, or in other locations as the engineers may direct. These joints are filled with bituminous paving cement.

After the blocks are laid and wedged and rammed as close as possible, they may be grouted with Portland cement mortar, as also before described for asphalt block, but it is becoming a common practice to use a bituminous paving cement filler.

This is heated till it is thoroughly liquid and will run into the joints freely when spread on the pavement. An excess of this bitumen is used, and while it is still hot there is spread over it a ½-inch layer of clean, coarse sand or dry crushed stone screenings with particles not exceeding ¼ inch and not smaller than 1-32 inch in size.

Some Other Bituminous Pavements

There are many other uses of bitumen in roadway work, but most of them are but modifications of the methods already mentioned. This branch of highway construction is a comparatively new departure, and as yet very little has been done to standardize the different methods. In fact, no ironbound rules could be drawn up to cover all cases, as local conditions and climate will always determine the proportions and manner of application. This is particularly true in those cases relating to the bituminizing of macadam or gravel roads, for though in every case the principle is the same, there are innumerable methods to arrive at the sought-for result, namely, a hard, homogeneous, waterproof and dustless wearing surface.

A pavement that is often mentioned as asphalt macadam is a modification of our tar macadam before mentioned. In consists in painting the finished road with hot asphalt (about 320 deg. F.), and while this is still hot a layer of small rock is spread on it. This is in turn painted as before, and over it is spread a thin layer of screenings or small stones and sand.

There are also a great many modifications in the "mixed method" of surfacing roads, the best example of which is "butilithic."

The cold mixing method is becoming quite popular of late. This consists in mixing the top course with a bituminous cement which is liquid at ordinary temperatures but which contains some volatizing material (like benzine). Many of these "cold asphalts" are controlled by patents.

One pavement of this last type that deserves special mention is a patent pavement somewhat after the lines of bitulithic, called "Westrumite." This asphalt cement is liquid at ordinary temperatures and is shipped in barrels or tank cars and is mixed cold (on the street) by hand or in a concrete mixer with proportions of broken stone, sand and mineral dust. It is then spread to a thickness of 1½ to 2 inches on a concrete or macadam foundation and rolled until hard.

This pavement has been used successfully in Brantford, Guelph, and Stratford, and presents a durable, elastic, non-slippery, waterproof surface, but it is somewhat inclined (particularly if recently laid) to ooze and soften up to a noticeable extent in warm weather. However, more care in proportioning and mixing the different materials may help to regulate this.

There is one more pavement of this class that deserves mention, namely "Amiesite." It may be described as another modified bitulithic surface for macadam roads and is composed of 90 per cent. bituminous cement and crushed stone.

On a Telford base is spread about 3 inches (loose measurement) of this material made with stone in sizes from ½ in. to 1½ in. This is rolled once and on top is placed a 1 inch filler course, consisting of Amiesite made of stones running from ¼ to ½ inch. The surface is then rolled and finished until it is compact and uniform.

This pavement has been used in many towns and on country highways throughout New York State, New Jersey, Pennsylvania, and adjacent states, and appears to be giving satisfaction.

The chief point patented in this pavement is the compound forming the bituminous binder in which they claim that all the soluble salts (common to other asphaltic cements) are neutralized, giving a material of uniform elasticity for different temperatures.

A new pavement that has just been patented is of interest on account of its radical departure from any material now on the market. It is called "Cork Brick." It consists of finely-granulated cork mixed with asphaltic cement and molded like asphalt blocks. When the bricks are laid on concrete, the foundation should first be covered with a layer of hot bituminous cement. It is stated that the bricks absorb less than 1½ per cent. of water by immersion, and that they afford an excellent foothold whether wet or dry. As yet these blocks are but an interesting experiment.

A pavement that has attracted widespread interest of late and received favorable comment in engineering journals is one devised about four years ago by E. W. Graves, city engineer of Ann Arbor. It is a concrete pavement with bituminous wearing surface, and consists of a 4½ inch gravel concrete base and a 1½ inch wearing surface, mixed one part cement to two parts sand. The concrete is laid in strips one-half the width of the street and 25 feet long, an expansion joint being placed every 25 feet across the street perpendicular to the axis and at each curb. The block is given a rough finish by means of a street broom. After finishing one section the form is moved across to the other side of the street and the other half laid right against that which has been previously placed, leaving as close a joint as possible in the centre of the road.

After the concrete has hardened the surface is sprinkled with a thin coat of hot bitumen, which is covered with a coat of sand. Approximately one-half gallon of bitumen is applied per square yard of surface and a cubic yard of sand will cover about 250 square yards, making a wearing surface from ¼ to ⅜ inch thick. Although common coal tar has been used in this work with good results, a specially prepared distilled tar was found to be more satisfactory. The people in Ann Arbor are

very enthusiastic over their pavement, and at present petitions are on file for over 100,000 square yards. It is stated that this pavement can be put down for less than $1.00 per square yard, which is figured on a basis of labor at $2.00 for nine hour day, cement $1.10 to $1.30 per barrel, and gravel at $1.00 per load of 1 1-3 cubic yards.

A prominent point in the foregoing is the lack of standardization of methods in vogue to acquire somewhat the same result. This is partly due to the fact that this branch of highway science is yet in its infancy, but the great controlling factors (as before emphasized) are the conditions, geographical, geological, financial, etc. Geographical will include the climate, location and purpose and requirements the road will have to meet. Geological may determine the materials used and quantity and quality of such, and the drainage and nature of the ground; lastly, the amount of money at hand to spend on the road will be a large controlling factor.

But no matter what method used or result sought, whether elaborate or crude, several points will be emphasized when it comes to using bitumen as a binder or cement. One of the most important is the proper proportioning of our materials. Firstly, the stone must be graded from the largest down to a powder, and each size proportioned as to reduce the voids to the greatest extent. Sufficient bitumen (but no more) must be used to thoroughly fill the remaining voids and evenly but thoroughly coat every particle of aggregate, so that when the mass is cold it shall present a density as near as possible to that of the solid rock from which the aggregate has been made or "within 5 per cent." of it.

Another point that has been noticed in many specifications and reports is that the work must be carried on in dry weather and materials and surfaces be thoroughly dry. This is a point that is often disregarded if the contractors are in a hurry to finish the job. This brings out the fact that when possible the best time to let contracts for bituminous pavements is in the early summer months. The writer has seen bituminous pavements (the contract having been let in the late fall) being laid during blinding snowstorms and drizzles.

A point of pre-eminence is the character of the bitumen, the different grades, essentials, etc., which have been mentioned. We must have as our binder a tar that will not soften in hot weather not get brittle during the cold. In other words, one that has a great elasticity and large temperature range between the melting and brittle points; however, we must not have one with so high a melting point that it will be too difficult to work. That is one of the disadvantages claimed for petroleum residuum compounds for use in tank waggons, as the steam coils will not make the material sufficiently fluid to flow readily through the hose. As yet the ideal bituminous cement is not on the market.

BIOGRAPHY

James W. Tyrrell, 1883

James Williams Tyrrell, C.E., O.L.S., D.L.S., was born on the 10th of May, 1863, at Weston, Ontario, where he received his early training, first at private schools, and later at the High School under the tuition of the late George Wallace, B.A.

At the age of seventeen he entered the School of Practical Science, Toronto, and there, during the first year, formed one of a class of eight. In his third or final year this class became reduced to two—G. H. Duggan being the other survivor. D. Burns of the class of the previous year graduated with the above two, and these three formed the graduating class of 1883.

During the summer vacation of 1882 Mr. Tyrrell accompanied the late Francis Bolger, P.L.S., as assistant upon the survey of the Township of Ratter, north west of Lake Nipissing, and there in the swamps of that district received his initiation as a knight of the chain and compass, and it was a strenuous initiation, well fitted to prepare him for later and more arduous experiences.

After leaving the School of Science in the spring of 1883, he obtained a position as topographer on the staff of the Canadian Geological Survey and for two years acted as assistant to Dr. Robert Bell, LL.D., the assistant director.

During those years he surveyed and mapped the shores and the 3000 islands of the Lake of the Woods.

In the spring of 1885 he obtained his commission as a Provincial Land Surveyor from the Ontario Government, and the same season was appointed hydrographer and meteorological observer to accompany a Dominion Government expedition to Hudson Bay and Strait. With this expedition, which was under the command of the late Captain A. R. Gordon, R.N., he sailed from Halifax in the S.S. Alert in May, 1885, and did not return until October of the following year.

During the intervening months Mr. Tyrrell was engaged in exploring and surveying the harbors and shores of Hudson Bay and Straits and in taking meteorological, tidal, and other scientific observations, all of which have been published in the departmental reports.

During the winter of 1886-7 he was engaged in Toronto in preparing the maps and charts of his surveys, and these have also been published by the Canadian Government and the British Admiralty.

In February, 1887, he obtained his commission as a Dominion Land Surveyor, and in the spring of that year obtained employment as an assistant engineer on construction of the International Railway of Maine—the eastern extension of the C.P.R. He remained on this work for nearly two years and gained much valuable experience, but during the autumn of 1888, hearing of a favorable opening for a surveyor in Hamilton, Ontario, he formed a partnership with the late G. B. Abrey, P.L.S., and opened an office in that city for the practice of municipal engineering and surveying. In the spring of 1889 he received the degree of "C.E." from the University of Toronto, and in June of the same year was married to Miss Isabel Macdonald, youngest daughter of the late James Macdonald, Esq., of Toronto.

For several succeeding years he devoted himself to private practice, and among his many successful undertakings built the first inclined railway in Hamilton at the head of James Street. This was opened for traffic on the 11th of June, 1892.

In the spring of 1893 he was invited to join his brother, J. B. Tyrrell, then of the Canadian Geological Survey, upon an extensive exploration of the so-called Barren Lands west of Hudson Bay, and, leaving his local business in charge of a partner, he was engaged upon that now historic expedition for a period of eight months, and performed with his brother a journey of over three thousand miles, and one of the most notable in Canadian history.

This remarkable exploration has since been graphically described and illustrated in "Across the Sub-Arctics of Canada," an entertaining book written by the subject of this sketch and published by Briggs & Co., of Toronto. Of this book Mr. F. C. Selous, the famous sportsman writes:—"I am not given to paying undeserved compliments, but I can truly say that I know of no more fascinating book of travel than 'Across the Sub-Arctics of Canada.'"

Besides the exploration above mentioned, Mr. Tyrrell, in whom the love of wild life is strongly developed, has made many long and interesting journeys, among which may be mentioned:—Mine surveys at Lillooet, B.C., in 1895; mine survey in various parts of Nova Scotia in 1896; mine surveys at Rainy River and at Red Lake, North Ontario, in 1897; mine surveys at Crow's Nest, B.C., and in New Brunswick, in 1898; mine and timber surveys at Lillooet and at Agassi, B.C., in 1899, and in 1903 mine surveys in various parts of Newfoundland.

Whilst engaged on surveys in the mountains of British Columbia in the summer of 1899 he received a telegram from the hand of an Indian courier asking him, on behalf of the Canadian Government, to undertake an exploration of the "Barren Lands" lying between Great Slave Lake and Hudson Bay. This work was undertaken and occupied eleven months of the year 1900, and was successfully carried out and fully reported upon.

In August, 1901, Mr. Tyrrell again responded to the "call of the wild," and took passage for the Klondike gold fields, where he followed with a fair degree of success, the occupation both of miner and surveyor for a period of one year.

The latter part of 1902 was spent in Hamilton, but many months of the succeeding years from 1903 to 1910 were spent on Dominion Government survey work in the provinces of Manitoba, Saskatchewan and Alberta. In all about one hundred townships were subdivided during these years, and whilst some surveys were performed under pleasant circumstances, others were accomplished under the most adverse conditions.

During the summer of 1905 a railway exploration survey was made for a private syndicate from Prince Albert via the Saskatchewan, Nelson and Churchill Rivers to Fort Churchill, and a complete map of Churchill harbour was made. The return of this journey was made by way of the Nelson River and Lake Winnipeg.

In the year 1906 Mr. Tyrrell was elected president of the Association of Ontario Land Surveyors, with which he has been actively identified since its inception.

He is at the present time head of the engineering and surveying firm of J. W. Tyrrell & Company, of Hamilton—the other members of the company being John E. Jackson, O.L.S., D.L.S., and Oliver R. Blandy, O.L.S. They enjoy the benefits of a large and profitable business.

Mr. Tyrrell takes an active interest in military affairs, being a captain in the corps of Guides, and he is the happy possessor of an ideal family of two sons and two daughters, none of whom have, as yet, chosen their callings in life.

A. S. McCordick, '09, has received an appointment to the staff of the city engineer of Sault St. Marie, Ont., on electric light and water power installation and distribution.

J. A. Elliott, '11, has been engaged with the Casner Electrolytic Alkali Co., of Niagara Falls, N.Y.

F. A. Robertson, '08, until recently with the Canadian Inspection and Testing Laboratories, has accepted a position with the Canadian Cement Company in their publicity department.

G. H. Bowen, '09, has engaged with the Hamilton Gear and Machine Co., Toronto.

V. A. Newhall, '10, is with the Department of the Interior. He is engineer of inspection of irrigation surveys at Calgary.

T. J. Farrelly, '11, has accepted a position with the Bell Telephone Company, at the head office in Montreal, on transmission engineering.

W. W. Gray, '04, is located at Edmonton, Alta., in the employ of the Edmonton Light & Power Co.

W. P. Brereton, '01, is in Winnipeg in charge of a scheme for bringing city water supply from Shoal Lake, Man.

H. H. Angus, '03, is discontinuing his consulting engineering practice to accept a position with the Canadian Domestic Engineering Co. in their Toronto office.

R. J. Fuller, '11, resigned recently from the staff of the Canada Foundry Company, to accept an appointment to the staff of the City Architect, Toronto.

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EDITORIAL

THE FRUITS OF LABOR

At the Engineering Alumni dinner, held recently in Toronto, our research scholars may have experienced occasional sensations of monstrous responsibility, developing into the disquieting forecast that they must succeed in producing something of material value from their undertakings, that the eyes of twelve hundred fellow School men are upon them; that the movement, in its initial stage will sacrifice its future unless it adorns itself with a full measure of success this year. In reality nothing was said to uphold or contradict such apprehension—they received no inkling from the graduate representation of its feelings in the matter of results, and hence the soil for consternation.

Whatever misgivings they may have entertained as to the relative responsible nature of their duties compared with those of

the crowned heads of Europe, they must, first of all, feel that every member of the graduate body wishes each of them real success and benefit from their year's labors.

The research fellows, moreover, and those in whose charge they work, are vitally interested in the outcome of their study and will derive from it all possible good. That is the universal graduate opinion. The Engineering Alumni Association is providing the funds to equip two men with a year's special training that will make them a greater credit to the School and its graduates, and therein lies the interest which it is taking in their progress. It is not vitally interested in the result, but will, to be sure, possess a pronounced degree of admiration for their men should the investigation work result in addition to useful knowledge in the special subjects under examination.

The men should feel assured that it is not a question of showing a material return, however, but that it is the earnest desire of the graduate body that each makes the most of his opportunities for research, let the outcome be what it will. If they do this, their efforts will have been successful, in so far as the supporters of the movement are concerned. And they must not attack their work of endeavouring to solve scientific problems under an unnecessary strain of responsibility. It has a semblance to a joke-writer trying to fill up a funny page against time, in which case the resulting columns are not abundant in masterpieces.

ENGINEERING SOCIETY ACTIVITIES

At its general and sectional meetings some very instructive papers have already been presented to the Society this term. Although the attendance at the School is smaller this year than usual, the fact is not noticeable at the different meetings. They have been unusually well attended.

The first meeting, on October 18th, was more introductory in nature than anything else, nothing by way of a paper on a technical subject having been attempted. President Ritchie called upon Dean Galbraith to address the students, which he did in a very general way, dealing with the objects and scope of the lines of instruction on the Faculty time table. The benefits of the Society to its members, and the opportunities it makes possible for them to take advantage of, formed a subject of interest to the newer men. Mr. T. H. Hogg, '07, gave a short history of the Engineering Society and the close relation of the graduate body to it, in the course of which he commented upon the excellent work of Mr. K. A. Mackenzie, '06, in the interests of both bodies.

The matter of the annual dinner was discussed, the general expression tending toward a dinner more "School" in its naturel with better facilities for an intermingling of students and graduates.

The first sectional meetings on October 30th, were extremely well patronized. Mr. E. A. James, '04, the Engineer to the York County Highway Commission, spoke to the civil section on "County

Highways—their Construction and Upkeep." His lecture was well illustrated, and dealt for the most part with the various methods of road building, and materials of construction, with a view to their durability and safety. He touched upon the value of dust preventatives, and explained the action and efficiency of a number of preparations now on the commercial market. In the discussion following, Mr. W. M. Treadgold, '05, referred to the splendid work that Mr. James is doing in the interests of good roads leading into the city. Professor Wright and Mr. A. T. Laing, referred to the steps that are being taken by the Faculty of Applied Science in providing an efficient course of instruction in this branch of engineering, the time having matured when it should form a necessary part of the training of School men.

The electricals and mechanicals were addressed by Mr. Wills Maclachlan, '06, on "The Business Side of Central Station Work." His paper, which was published in the November issue of Applied Science, was of particular value to undergraduates, dealing as it did with points of importance on the commercial side of electrical engineering. The information his paper contained is not at the disposal of the average student in this course, and is only learned, some times inopportunely, by personal contact with office routine after graduating.

The miners and chemists were addressed by Professor Guess, of the department of metallurgy, whose resume of a trip through Peru, was of special interest and full of instructive data concerning engineering work in the south. He touched upon the transportation facilities to the interior region and also upon the progress that was being made on the Panama Canal.

Mr. J. A. MacMurchy, '96, chief draftsman for the Westinghouse Machine Co., East Pittsburgh, a paper from whom was published in March, 1910, issue of Applied Science, as a previous address to the Engineering Society—"A Novel Form of Reduction Gear," again favored the society with a paper at its general meeting on November 15th. The lecture, which was profusely illustrated with lantern slides, dealt with "The Evolution of the Reaction Steam Turbine." Many valuable points connected with the design and manufacture were exemplified. The large audience was fortunate in having the address, which was of special value to them, delivered in such an able manner by Mr. MacMurchy, he having an excellent conception of the parts of particular interest and value to the undergraduate, combined with a thorough knowledge of the subject itself. Dealing with the earliest forms of the steam turbine, the speaker traced the history of its development down to the present time and spoke of the methods of construction of the various types. He described high and low pressure turbines, pointing out the advantages and difficulties met with in endeavoring to obtain the highest possible efficiency. The wheel reaction of the Parson's turbine in 1884, was traced through its development to 1896, when the Westinghouse Co. acquired the patent right for America, and to the year 1907, when the special demand came for turbines of larger units.

He explained the modern turbines of high power and the methods that were being employed to secure better efficiency in them. The special adaptation to develop power and to use the exhaust steam for heating purposes was also touched upon. The lecturer spoke emphatically of the skill in design and workmanship necessary to obtain accurate results in turbine manufacture.

Professor R. W. Angus, in moving a vote of thanks, outlined the general replacement of turbines and other forms of rotary engines for reciprocating engines. He stated that two turbines of Mr. MacMurchy's construction are being used on the high-pressure fire system in Toronto.

It is to be hoped that Mr. MacMurchy can rearrange the subject matter of his paper for publication in Applied Science, that it may be of like benefit to graduates. His devotion to the subject, his sacrifice of time and duties in coming to Toronto, to address the Engineering Society, and his generous treatment of the methods of construction, were very heartily appreciated by the students.

On November 25th, a special meeting was called to hear Mr. E. L. Cousins, '06, Engineer to the Toronto Harbor Commission. Mr. Cousins is in the front rank among recent graduates of the School, and his professional attainments since graduation are interesting. Until 1910, he was division engineer for the Grand Trunk Railway Co., with headquarters at Toronto. In July of that year he became assistant city engineer, in charge of railways, bridges and docks, from which he resigned after 18 months' service to accept his present position with the Harbor Commissioners. His success in this capacity has claimed the interest of every citizen of Toronto, and of all the harbor engineers throughout America, in his comprehensive set of plans for the development of the city water-front. This was the subject of his address to the Society at the special meeting. In February of this year preliminary work was commenced under his direction, to make a complete survey of the water-front, from Victoria Park to the Humber, together with a hydrographic examination of a harbor bed. Some 8,000 soundings were required to furnish data concerning the depth of water and ultimate depth of rock. A complete investigation was made of the nature of the material with a view to reclamation work and to dredging the harbor to afford proper facilities for docking boats of any size.

Then, on December 13th, another important general meeting was held, the speaker being Mr. J. Keele, '93, who described the resources of Canada for the clay industries. His lantern slides were interesting views of clay deposits in various parts of the Dominion. his paper appears elsewhere in this issue. Mr. Keele was commissioned by the Dominion Government to make a complete investigation of the clay resources of Canada. His work in the field is now being supplemented by a laboratory investigation into the nature and properties of several tons of samples procured from the numerous clay beds. This is being carried on at present under Mr. Keele's direction in the metallurgical laboratories of this institution.

EXCURSIONS

Several trips of importance have been made to industrial plants in and out of the city during the past month. Mr. T. R. Loudon took about 160 men of the senior years to the works of the Lackawanna Steel Company at Buffalo. The trip was, as usual, most instructive, and the management of the Company, and Mr. Loudon as well, were the recipients of expressions of appreciation from the students for their painstaking care in affording them ample opportunity to see the various stages of manufacture. The excursion was certainly one of pleasure, but primarily one of instruction, and no small thanks is due Mr. Loudon for his yearly efforts in making the trip a complete success.

Another profitable trip was to Niagara Falls. About 40 men of the fourth year, accompanied by Prof. R. W. Angus, were the guests of the Ontario Power Co., The Canadian Niagara Power Co., and the Toronto-Niagara Power Co., on the Canadian side, and the Achison Graphite Co., on the New York side of the river.

On the occasion of the Intercollegiate post series game between McGill and Varsity at Ottawa, the fourth year men in large numbers were afforded an opportunity of visiting several industrial works in that city and Hull. Among these might be mentioned the visit to the large plant of the E. B. Eddy Co., where a most courteous reception was given them by the management. The different departments devoted to the manufacture of matches, fibre-ware, paper, etc., were all investigated. Prof. Gillespie, who is accomplished in the knack of enducing educative replies from guides, for the benefit of the men in his charge, accompanied the party.

The men taking the sanitary engineering course have taken a few afternoons off, and count them exceedingly well spent. Especially so in the case of their trip to Stratford, Galt, Berlin and Preston, with Dr. Amyot and Prof. Gillespie accompanying them. At Stratford the city engineer, Mr. A. B. Manson, '09, made their visit most enjoyable and instructive. The old septic tanks were in the process of cleaning, and the new sprinkling filters, which have since been put into successful operation, were just being finished.

In Galt, Dr. Vardon, the M. H. O., directed their attention to the waterworks system. The supply is provided through a system of gallery construction as well as from wells.

At Berlin, besides a close examination of the most efficient and up-to-date slow sand filter in the province, there was a beet sugar manufactury to inspect. Dr. Amyot was most instrumental in affording every chance for the men to get acquainted with the processes. The slow sand filter and septic tank system in Preston formed the basis of a visit there that proved also of value.

In Toronto, the development towards more and satisfactory disposal of sewage has not been overlooked. Prof. Gillespie and Mr. Laing accompanied a party of men to the Toronto sewage disposal works, where Mr. J. H. Nevitt, '03, who is assistant engineer, main drainage department, acted as guide and took pains to elucidate the functions of the various compartments and machinery, as planned

for the finished work. A similar visit was made to the filtration plant at the Island.

On December 6th the Government experimental stations, in charge of which is Mr. F. A. Dallyn, '09, was also visited under Dr. Amyot's guidance.

The men in roadway engineering have made several trips to local points to examine the season's work in road building. The Lake Shore Road, Weston, and North Toronto roads were among those visited. The efforts of Mr. A. T. Laing and of Messrs. E. A. James, '04, A. E. Jupp, '06, who was superintendent of that part of the work done by Routly, '06, and Summers, '07, roadway engineers, Haileybury, and J. T. Howard, '13, resident engineer, made the trips very profitable.

SOCIAL FUNCTIONS

Owing to the necessity of holding the Engineering Dance earlier in the Easter term than usual, it has been given the place of the annual school dinner in January, while the latter will be held on February 13th. It was announced in the October issue that the dinner might be held toward the end of the present term, but owing to the numerous meetings and other functions, the idea was necessarily discarded. The engineering dance will be held on Friday evening, January 24th, in the Knights of Columbus hall. The old gymnasium is now a matter of history, its demolishment being the first stroke preparatory to the erection of the new Massey Memorial building. Consequently, in the absence of another building in the University that could adequately accommodate this important function, the hall on Linden St. providing accommodation for 225 couples, was engaged. Every effort is being made to eclipse the Engineering dances of previous years, which have already superceded all other University social functions.

THE ELECTRICAL CLUB

With the close of this University year the University of Toronto Electrical Club completes the eighth year of its existence. The members of this year's executive are:

President	R. J. Allen, '13.
Vice-President	R. G. Matthews, '14.
Secy.-Treas.	F. R. Sims, '13.
Councillors	W. B. Buchanan, '13,
	P. H. Mills, '14,
	E. D. W. Courtice, '14.

The first meeting of the year was called on October 22nd, 1912, to hear Mr. Horatio A. Foster, Mem. A.I.E.E., Mem. A.S.M.E., Consulting Engineer of New York and Editor of *Foster's Electrical Engineer's Handbook*. His subject was Engineering Reminiscences, and the talk was full of interest to the students in that it showed the peculiar difficulties under which the pioneers in electrical engineering

in this country worked. Mr. Foster also gave an idea of the rapid strides made in electrical work in the course of one man's life time. The meeting was well attended despite the inclement weather and about fifty students were on hand to thoroughly enjoy the most interesting talk.

The next meeting was held on Nov. 6th, and was addressed by Prof. R. W. Angus. His subject was "Turbine Pumps and their Application." The address was well illustrated with slides and the subject was well handled by Prof. Angus in his usual clear-cut style. The meeting was thrown open for discussion afterward and the number of questions asked evinced the interest taken in the address by the members.

The third meeting was held on Nov. 28th. The subject "Electrical Illumination" was taken by Messrs. M. B. Hastings, '11, and J. H. W. Joyner. Mr. Hastings presented his subject in his usual breezy style. A good attendance turned out to hear him.

As the object of the club is two-fold, viz., to give the members an idea of the most modern practice in mechanical and electrical engineering by means of papers more technical than are given in the meetings of the Engineering Society, and secondly, to develop the ability of the students in expressing themselves in public, the latter part is accomplished through the discussions on the paper of the evening. These discussions are always helpful and often bring out points which the speaker has failed to make clear.

Besides the fortnightly meetings, during the fall term, there have been trips made to points of interest in the city and neighboring places. On Nov. 9th, a visit was made to the Russell Motor Car Co. works, a large number of members availed themselves of the opportunity of visiting this plant. Another trip was that made to the Sunbeam Lamp Co. plant, while a third excursion was to Niagara Falls under the direction of Prof. Angus, where the different power plants were visited. These excursions are very profitable to the students in that they give them a chance to see something of the methods and organization of the different manufacturing and power companies.

By such excursions and by its meeting the club is endeavoring to fill a place in student life by opening before the members the opportunities in the field of mechanical and electrical engineering, a purpose which in itself justifies the existence of the Club, and the flourishing condition of the Club shows the degree to which the students appreciate the effort.

THE ARCHITECTURAL CLUB

The Architectural Club of the University of Toronto was formed during the latter part of 1911 and during the first few months of its existence made a little start towards bringing the men of the department in closer touch with professional interests.

An added impetus was given to the club, however, at the beginning of the present term, due largely to the changing character of the Department of Architecture, in which the artistic has begun

to supplant to a certain extent the engineering tendencies of the early days. Two of the meetings have been held at down town tea-rooms, and the concensus of opinion is that the presence of "eats, smokes," and good fellowship, coupled with a purely informal talk by a professional man who is "doing things" will do more for the growing club than the presence of a scattering of men, in a large class-room, and attending them with a feeling that it is a duty, could ever do.

The executive of the present year have attempted to broaden the scope of the club by obtaining permits to visit all the buildings in the course of erection on the grounds. They also hope to have trips over large structures when they are completed and during the course of erection, with a talk by the architects in charge on the actual scene of operations.

Four meetings have been held during the present term and all have been largely attended. Mr. J. B. K. Fisken, B.A.Sc., '10, opened the year with a travel talk on Southern Europe. Mr. John M. Lyle, the honorary president of the club, on "Style in Architecture," spoke at the next meeting which was the first held down town. Mr. J. Keele, '93, talked later in the year on "Colour in Design," and Mr. J. P. Hynes closed the meetings of the Christmas term with an interesting discussion on architectural education.

In summary, the club has held a very successful year and should become a connecting link of vital importance between the professional interests and the School. Mr. John M. Lyle, the honorary president, has always taken a great personal interest in architecturel education, and the club is to be congratulated on having him for the premier position.

A great deal of thanks must be tendered to Prof. C. H. C. Wright for the kindly interest and able advice he has given throughout the creative period of the club.

The executive of 1912-13 is made up as follows:—Mr. John M. Lyle, honorary president; Burwell R. Coon, '13, president; L. C. M. Baldwin, '13, vice-president; J. Murray Robertson, '14, treasurer; Merrill Denison, '15, secretary; A. Curry Wilson, '14, councillor; Kenneth C. Burness, '15, councillor; Francis A. Swinnerton, '16, councillor.

THE ENGINEERING PROFESSION

An Impassioned Appeal for Closer Organization of Qualified Engineers

By P. D. Hardup, B.Sc.

The present moment offers a rare opportunity to address a few words to you, dear Editor, anent the subject of "The Engineering Profession." (I think that is the usual manner adopted to introduce a subject of this kind). During the past year engineers in general and the engineering profession in particular have been freely discussed, boosted, abused and generally criticised by the press throughout the Dominion.

Being so well known to most of the engineers of the country—for who can say that nearly all engineers at one time or another, and most of them all the time, are not well acquainted to Pretty D. Hardup?—I write with some authority.

Of course, sir, you can understand that to deal with the engineering profession with any degree of fairness and propriety would require an extensive treatise reaching into many volumes. Just stop and imagine the writer trying to treat the queston alone of the lady engineer in less than 500 pages. The possibilities of that one chapter of the profession by itself, which was barely suggested in ten or fifteen pages written for APPLIED SCIENCE in 1907 by that eminent engineer, E. C. Easy, C.E., would cover several volumes in themselves, and the "School" has had some experience here. We have only to search amongst the handsome faces of the B.A.Sc.'s of 1911-12 to find that out. We cannot, therefore, in but a page or two, make more than a few cursory statements on the subject which, perhaps, is the farthest reaching one that could be recorded.

The first question that comes before us is: What is an engineer? Without turning up one of those painful encyclopediae that that book agent "stung" you with last week (oh, engineers are sure some easy bunch!), let us take the definition given by a reliable dictionary. "Engineer, [formed on type of charioteer, musketeer, etc.]. Originally one who managed military engines or artillery;" (ah ha, there's where our 2nd Field Company plays its part); "now, one who manages a steam engine or has to do with the construction of steam-engines or steam-machinery," (exit, 2nd Field Company, enter, donkey-engine operator—we're progressing); "or a person skilled in the principles and practice of engineering, either civil or military," (enter the lady-killer and the boy scout, arm in arm), and so on, *ad. lib.*

So we all must agree that a person calling himself, or herself, an engineer, and not further qualifying the term, may rightly be inferred to operate an engine for some railroad. Why, I know men who go about wiring houses who call themselves electrical engineers. And, pray, why not? The engineering profession is certainly one open profession. It is the one profession that typifies British freedom. Any one can be an engineer, whether he runs a steam engine, a gasoline launch, installs water-pipes, or does a thousand other things.

The doctor, the lawyer, the chartered accountant, the dentist, the school teacher, the veterinary surgeon, and any one of several other respected and refined professions can rest fully and absolutely assured that they are what they say they are and no one can gainsay him, or her, with impunity. Not so the engineer. Half the engineers in the country can show nothing more than some class of membership in the society, and many even have not that. And does that membership really show anything in particular as far as actual qualifications are concerned, in most cases; and does it afford any real, definite and protected standing that will permit a man, or not permit him, to build bridges, or engines, or buildings, or railroads?

There is one profession, like ours, yours and mine, dear Editor—the ministry. Goodness knows anyone can be a minister. I understand that there are colleges in the States that turn them out, degree and all, after six months. But even that is not always necessary. If a minister gets tired of one denomination, he joins another; if he is thrown out of one he forms a new one and sometimes becomes a wonderful bishop or a divine prophet. Thus we have "some hundreds" of him in America.

So you see from this how closely related are these two professions—the ministry and engineering. The general system and the organization in each profession are the same in practice and only different in appearances.

I noted that a couple of dailies recently carried want ads. for barbers' helpers and bakers' helpers under the heading of "Mechanics Wanted." While these may be right, I do not know, I imagine now that the plumbers call themselves "sanitary engineers" and city commissioners style themselves "city engineers," that head bakers and head barbers will be advertised for under the heading of "mechanical engineers." By that time scavengers will be "sanitary experts."

I might elaborate along these lines, my dear sir, till I am devoid of breath. But what is the good? The conclusion is the same. But let us keep up hope. After all we have the matter in our own hands. It will only be a matter of time when engineers will hold their profession with as much pride and dignity as do the doctors, the lawyers and the others. These are all well organized, as even the bricklayers, the carpenters, and the plumbers are organized.

The engineer is not organized. He is not necessarily a graduate nor a member of any body or organization, except when he becomes a surveyor, and very often may be a poorly informed person.

"So there you are, and if you are not, where are you?" to quote the words of a popular comic opera.

ANNUAL DINNER OF CLASS '15

"One of the best class dinners I have ever attended," was the way Dean Galbraith described the annual dinner of the class of '15. The dinner itself, held at McConkey's on Wednesday, Dec. 11th was a splendid success, and reflected much credit on the efforts of President Steel and his executive. Several innovations were worked into the program, the most successful being the presence of the "Toike-Oikestre." Mr. Leach, the leader of the orchestra, has a splendid aggregation of musicians, and they made it very enjoyable, both during the banquet and also by the selections which they rendered during the progress of the toast list. After the toast to the king, the toast to the "School" was proposed by Mr. C. K. McPherson, who outlined briefly the many and varied lines of work in which graduates of the "School" are at present engaged.

Dean Galbraith, in replying was, as usual, very interesting and very humorous. He explained that the reason a man comes to university is to be educated like his fellow, like the men with whom

he will have to compete during his business career. The greatest asset a man can possess is to be placed on a level with his competitor, as far as education is concerned. The Dean said that an educated man was the only man who was not afraid to discuss things with which he was not perfectly familiar. He referred to the immense number of subjects being taught at the present time, due to the fact that it was very difficult to get rid of the old subjects and to give room to the newer and more up-to-date things that were so necessary for success to-day. In closing he emphasized the value of experience and explained that while the graduate of to-day was educated along a great many more lines than the graduate of ten years ago, still the older man with the wider experience holds an advantage over his younger rival.

Mr. E. M. Monteith proposed the toast to the University, which was replied to by Dr. W. H. Ellis. Dr. Ellis spoke of the different mental pictures or conceptions of a university which were held by different people. To some it was a collection of buildings, of the nature of a factory and doing a regular commercial business; to others it was a heaven, whose streets ran with beer while the saints walked around with their faces spotted with court plaster. Some would associate thoughts of their university with odours of the dissecting room or the smell of sulphuretted hydrogen, while a large majority think of their alma mater as the training ground for their social and intellectual natures.

The inference to be drawn is that a man's idea of his university reflects the character of the man himself and the side of college life which appealed most strongly to him during the course.

The toast to "Modern Engineering" was proposed by Mr. D. B. Webster, who gave an account of the work of the chemical engineer. This was very interesting as the chemical engineering course is comparatively new and not very well understood by the majority of the students.

In replying to the toast, Mr. T. R. Loudon said that he did not have any work with the second year and consequently he did not see them as often as he had during the first year. He referred to one occasion towards the first of the term when he looked out on the south campus upon a scene of activity and evidently considerable interest. On this occasion he had "seen" more of the men than ever before. He referred to it as a very poorly concealed "skin" game. In dealing with the trend of modern engineering Mr. Loudon said that until quite recently engineers had not been vitally interested in the commercial or business end of their work. They had been called in to give advice on certain undertakings, or to carry out the mechanical work in connection with certain projects, but the financing and developing of the work had been left to other men. To-day that is all changing, the engineer sees that he has fields of work along commercial lines; that the separation of business and engineering is not imperative. There is no necessity for the business man to make the huge profits, while the other man does all the planning and constructing. To accomplish this end the speaker showed

that the engineer must have a thorough knowledge of costs and cost systems in order that he may speak with accuracy when he has to answer the question, "How much will it cost?"

"Class '15" was proposed by Mr. J. T. Mogan, who referred to the quotation applying to his toast, "Blessed are the Peacemakers." Mr. Mogan intimated that the ability of the year in the "piece" making line had been fully demonstrated on several occasions but he thought that the efforts of peacemakers had not always been appreciated.

Mr. J. Roy Cockburn, in response to this toast thanked the boys for the honor they had conferred upon him in choosing him as their patron saint. He assured them of his interest in the year, and in closing gave them a very excellent motto in the form of Kipling's description of a perfect man, which runs in part:—

If you can keep your head when all about you,
Are losing theirs and blaming it on you;
If you can trust yourself when all men doubt you
And make allowance for their doubting too.....

The last toast on the list was the one to athletics. It was proposed by Mr. E. H. Jupp, of hockey fame. He outlined briefly the athletic endeavours of '15, dwelling chiefly on the fact that the aim of the class had been to interest more men in athletics and to afford them opportunities to indulge in the different branches that appealed to them. To this end, inter-section leagues had been formed in hockey, baseball, and this fall, in rugby. In the hockey section the Electricals had been "champs," while in rugby they had to give place to the civils. The year had also made a very strenuous fight for the Loudon shield, emblematic of the inter-year hockey championship at the School.

Prof. C. H. C. Wright, in reply, said that he thought athletics were a very necessary part of a man's college education, the training he received in athletic competition being invaluable. He spoke of the big men of athletics who were members of year '15, "Pete" Campbell, captain of the "firsts" and "Dusty" Brown of Ottawa-McGill reputation and others who had helped to win honor for the university. Then in the inter-faculty we had the honor of winning the Mulock Cup, largely through the efforts and hard work of the energetic manager, Roy Cavers. We must give much credit, it is true, to the first year men, but still the men of year '15 made a brilliant showing and could be relied upon, when a hard game was ahead, for such men as Catto, the captain, Daniels, Cockburn and Adlard, Wallis, Graham and O'Reilley. Prof. Wright noted that on consulting the class lists of last year one would almost infer that honors in examinations had been made a condition for membership on the team.

At the request of President Steel, Prof. Wright gave a detailed description of the wonderful new gymnasium and club house which is now in course of erection, and which we owe largely to the interest and efforts of Mr. Vincent Massey.

After a vote of thanks had been tendered to the guests, the executive and orchestra, the evening was brought to a close by singing our national anthem.

THE ALUMNI DINNER

The Toronto Branch of the Engineering Alumni Association held its semi-annual dinner on Dec. 17th, the president, J. C. Armer, '06, occupying his official chair. Dean Galbraith honored the occasion by his presence, and the one hundred School men who represented the graduates of his School were delighted to have him as their guest and to hear him at his best. In calling the members from refreshment to attention the President expressed his pleasure at the good attendance despite the numerous counter-attractions for the same evening. It was regretted that the meeting of the Society at Chemical Industry at the same hour prevented the attendance of Dr. Ellis and a number from his department, including Mr. Shaw, one of our research scholars. Professor Haultain, W. E. H. Carter, and a number of others, whose great interest in the Scholarship movement occasioned an assurance that they would be there with something of importance to say, were keenly missed.

At the head table, besides the Dean, and Mr. Armer, were Prof. L. B. Stewart, C. H. Mitchell, G. R. Mickle, E. A. James, H. W. Price, T. R. Loudon, and T. H. Hogg.

The discussion of the evening surrounded the progress of the research scholarship movement. The secretary described what had already been done, particularly from the financial view. The enterprise had been a topic of conversation among a number of ardent School men for several years. In May, 1911, the Association drew up and adopted a set of by-laws to govern scholarships. During a few months in 1911 a canvass among graduates resulted in contributions to the value of $950.00 yearly for three years. Of this amount about $825. had already been collected as first and second payments. First payments amounting to $320. had not as yet been received. In June, 1912, a further call for subscriptions netted $250. yearly for three years. Of this $210 has already been received as first payment.

Thus, before the awarding of two scholarships last October, the graduates had subscribed $1,200 yearly for three years.

The two scholarships, to the amount of $500 each, are being paid in six equal monthly instalments, the first in October, 1912. The March payment will make a total of $1,000. expended towards research in the laboratories of the School. The only other expenses are those incidental to furthering the movement and general items of printing, postage, exchange on cheques, amounting in all to $111.75 since May, 1911.

Dean Galbraith, in commenting upon the great value of the movement, expressed his opinion that each research scholarship must be governed by its own particular conditions, and that the prime difficulty for the association lay in defining these conditions. Stress was brought to bear upon the importance also of what scien-

tists had previously solved before attempting an invasion into the realm of knowledge undiscovered. The proper selection of graduates to carry on our research work—men specially gifted—means much to stimulate and improve research. Finally he warned us to expect disappointments here and there in our work, and not to hope for success to crown every effort.

C. H. Mitchell spoke encouragingly of the movement. He intimated that in the graduate body there would be many with problems of vital importance to them in their work, but who had neither the time, facilities nor ability for research themselves, and who would gladly present their problems for consideration, if required, believing that if these problems were given to the men who have the ability for such investigative work, material good would ensure. He also suggested that our present research fellows, Messrs. Shaw and Dobson, should be communicated with by those graduates who are confronted with problems of similar nature.

Professor Price explained the method adopted by Mr. Dobson in studying the disturbances in high tension transmission lines and described how good progress had already been made in perfecting an automatic operation of the oscillograph.

In the course of the evening's talk the announcement was made of the election of T. R. Deacon, '91, to the mayoralty chair of the city of Winnipeg and was given a rousing reception.

The "Toike Orchestre" furnished quite sufficient music to eliminate all the ear-marks of a business meeting and was accorded a unanimous vote of thanks for its kindness in taking such a prominent part in the evening's proceedings.

M. B. Watson, '10, and T. A. Fargey, '09, have entered the employ of the Toronto Electric Light Co.

W. Almon Hare, '99, president of the Hare Engineering Co., Limited, Toronto, has returned from a summer spent in Europe.

F. H. Sykes, '05, has been appointed chief examiner of plans for the city architects' department, Toronto. Mr. Sykes was previously assistant structural engineer in this department.

H. P. Rust, '01, has been appointed engineer-in-charge of one of the largest hydro-electric developments in the West, by the Great Western Power Co., in San Francisco.

Wm. Snaith, '07, who was associated with Frank Barber, bridge and civil engineer, Toronto, is secretary-treasurer of the Thor Iron Works, Limited, a new corporation equipped for the fabrication of steel tank and plate work, steel trusses and light structural work.

DIRECTORY OF THE ALUMNI

Giving each month, in alphabetical order, the location of a number of the graduates. The entire list will be reviewed in the twelve issues beginning November 1912.

The graduates will confer a favor by advising us of any and all instances where the list is not up-to-date. Addresses unknown, or no longer correct, are hard to eliminate entirely from our records. If graduates will see that the information given about *themselves* is exactly as it should be, and that that concerning their class mates is also correct to the best of their knowledge, the department will soon be most reliable.

B (*Continued*)

Beith, R. E., '09, is in the employ of the Department of Public Works, Toronto.

Bell, G. G., '05, is with Sawyer & Moulton, a firm of consulting engineers, Portland, Me.

Bellisle, J. P., '06, deceased, May, 1906.

Bennett, G. A., '09, is, according to last report, with the Department of the Interior, Calgary. His home is in Edin, Ont.

Bergey, A. E., '94, is an instructor in the Carnegie Technical Schools Pittsburgh, Pa.

Berry, E. W., '10, is on Dominion land survey work, Department of the Interior, Ottawa. He is a D.L.S. man.

Bertram, G. M., '01, is manager of the Joplin, Mo., branch of the Sullivan Machinery Co., manufacturers of mining and quarrying equipment.

Betts, H. H., '06, is in Rio de Janeiro, Brazil, for the Rio de Janeiro Tramway, Light & Power Co.

Beynon, D. E., '06, is in the employ of the Dunlop Tire & Rubber Goods Co., Toronto, as superintendent.

Billings, J. H., '11, is in Cochrane, Ont. We don't know upon what kind of work he is engaged.

Bingham, H. C., '10, is in the office of the city engineer, Moose Jaw, Sask.

Birchard, E. R., '09, is in the employ of the Russell Motor Car Co., West Toronto, in the transmission gear department.

Bissett, D. C., '10, is engineer for the Dome Mines, Porcupine, Ont.

Bissett, G. W., '06, is mill superintendent for the Canadian Exploration Co., Limited, at Naughton, Ont.

Bissett, J. R., '11. His home is in Kincardine, Ont. We do not know his present employment.

Black, G. E., '08, is with the Ontario Government as roadway engineer, and is at present in charge of work at the Ontario Prison Farm, Guelph.

Black, R. G., '95, is managing director of the Federal Engineering and Supplies Co., Toronto.

Black, W. D., '09, is superintendent of the eastern branch of the Otis-Fensom Elevator Co., with headquarters in Montreal.

Blackwell, R. H. H., '10, is resident engineer for the Canadian Northern Ry. at Biscotasing, Ont.

Blackwood, A. E., '95, is manager of the New York office of the Sullivan Machinery Co.

Blackwood, W. C., '06, is instructor in physics, Technical High School, Toronto.

Blair, W. J., '02, is carrying on a civil engineering and surveying practice, with office in New Liskeard, Ont.

Bleakley, J. F., '85, is engaged in a general engineering practice at Bowmanville, Ont.

Blizard, D. C., '09, is in the engineering department of the Toronto Electric Light Co., Toronto.

Boeckh, J. C., '06, is in Toronto, and is with the Boeckh Brush Co. as a member of the firm.

Bonnell, M. B., '04, whose home is in Bobcaygeon, Ont., has no business address with us at present.

Boswell, E. J., '95, is on the engineering staff of the Canadian Pacific Railway Co., with residence in Toronto.

Boswell, M. C., '00, is lecturer in organic chemistry, University of Toronto.

Boswell, W. O., '11, is in electrochemical work. His home address is 25 Roxborough St. W., Toronto.

Boulton, W. J., '09, for several years with the Welland Ship Canal

engineering staff, and on a post graduate course last year, is in the West this fall.

Boustead, W. E., '90, deceased.

Bow, J. A., '97, is in Great Falls, Mont., with the Boston & Montana Mining & Smelting Co.

Bowen, G. H., '09, is chief draughtsman for the Hamilton Gear and Machine Co., Toronto.

Bowers, W. J., '01, deceased, December, '06.

Bowes, H. F., '08, is superintendent of the Warren Bituminous Paving Co., Toronto.

Bowman, A. M., '86, was a member of the Pennsylvania Contracting Co., Pittsburgh, when last heard from.

Bowman, E. P., '10, His home is in West Montrose, Ont. We do not know his professional activities.

Bowman, F., '11, is with the Dominion Biidge Company in the office at Lachine, Que.

Bowman, F. M., '90, for ten years with the Riter-Conley Mfg. Co., as secretary and director, is now vice-president and director of the Blau Steel Construction Co., Pittsburgh, Pa.

Bawman, H. D., '07, whose home is in London, Ont., is with H. D. Symmes & Co., Niagara Falls, Ont.

Bowman, H. J., '85, is a member of the firm of Bowman & Connor, consulting municipal and structural engineers, Toronto and Berlin, Ont. It was Mr. Bowman who contributed the first paper read before the Engineering Society. Its title was "North-West Surveys." It was not published in the Proceedings, as Mr. Bowman went to the front in the Rebellion of '85 before getting his notes in shape for printing.

Boyd, D. G., '94, is in Toronto, in the Department of Lands and Mines, Parliament Buildings.

Boyd, W. H., '98, is in Ottawa, topographical branch, Geloogical Survey, Department of the Interior.

Brace, J. H., '08, for three years with the New York Telephone Co. plant and equipment departments is now with the Bell Telephone Co., in Montreal in the same capacity.

Brackenreid, T. W., '11, is in the employ of the Canadian General Electric Co., in Peterborough, Ont.

Brady, W. S., '07, until recently with the Westinghouse Electric and Manufacturing Co., Pittsburgh, is at his home in Toronto at present.

Brandon, E. T. J., '01, is assistant engineer for the Hydro-Electric Power Commission, Toronto.

Brandon, H. E., '06, is chief engineer of the Vulcan Iron Works, Winnipeg, Man.

Bray, L. T., '00, is in Edmonton, Alta., in the Department of Public Works.

Brebner, G., '85, deceased, Feb. 21, '07.

Brecken, P. R., '08, is assistant secretary Y.M.C.A. with headquarters in Toronto.

Brereton, W. P., '01, is in Winnipeg, Man., He is engineer in charge of the city project to supply water from Shoal Lake.

Breslove, J., '03. We do not know his present address. He was in the steam turbine department of the Westinghouse Machine Co., Pitts burg, when last heard from.

Brian, M. E., '06, is city engineer of Windsor, Ont., and also engineer for several adjacent townships,

Bristol, W. M., '05, is in the Halifax, N.S., office of the Canadian Westinghouse Co.

Broadfoot, F. C., '06, is engaged in concrete contracting work at Coquitlam, B.C.

Brock, A. F., '10, is with the Canadian Copper Co., at Copper Cliff, Ont.

Brock, W. M., '11, is taking post graduate work in the Faculty of Applied Science and Engineering.

Brodie, W. M., '95, is, to the extent of our present information, with the Green Engineering Co., Pittsburgh, Pa.

Broughton, G. H., '07, is manager of the People's Trust Co., Penticton, B.C.

Broughton, J. T., '01, is chief engineer of the Scotdale Foundry & Machine Co., Scotdale, Pa.

Brouse, W. H. D., '11, is in this city, with Smith, Kerry & Chace.

Brown, J. M., '02, was in the steam turbine department of the Westinghouse Machine Co., Pittsburg, when we last heard from him. We do not know his present address.

Brown, T. W., '06, is engaged in surveying and civil engineering work at Saskatoon, Sask.

Brown, D. B., '88, who was, when last heard from, locating engineer, Grand Trunk Pacific, is on our list of unknown addresses.